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(54) Title: SYSTEM AND METHOD FOR PROVIDING A SPEED WARNING AND SPEED CONTROL

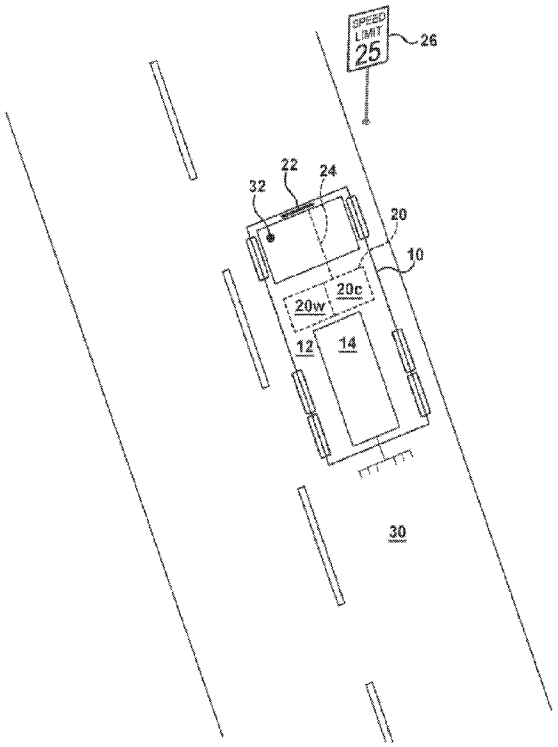

Fig. 1

(57) Abstract: A controller is adapted to receive signals indicative of an image including a representation of a posted speed limit for a current section of a road on which an associated vehicle is traveling. The controller evaluates die image to: identify the posted speed limit, and dynamically determines i f the posted speed limit is above a predetermined threshold speed limit. Only if the posted speed limit is above the predetermined' threshold speed limit, the controller sets the identified posted speed limit as a warning threshold. If a speed of the associated vehicle is more than a predetermined range over the warning threshold, the controller transmits a waning signal to a notifier for notifying an operator of the associated vehicle and controls a speed of the vehicle based on the posted speed limit..

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SYSTEM AND METHOD FOR PROVIDING A SPEED WARNING AND SPEED CONTROL

Background

[0001] The present invention relates to vehicle speed warning and regulation systems. It finds particular application in conjunction with selectively using sign recognition for warning a vehicle operator about a vehicle's speed and controlling a vehicle speed and will be described with particular reference thereto. It will be appreciated, however, that the invention is also amenable to other applications.

[0002] Speed limits and driving conditions along any given route may change frequently, particularly in urban settings. In addition, along a given route speed limits may change according to the time of day, such as during school hours or rush hours. The current and accepted method of informing the driver of the speed limit is through posted speed limit signs on the side of the road. However, when multiple speed limit signs are posted for a single section of road (e.g., both a school time speed limit and a non-school time speed limit in a school zone), a driver must determine which speed is applicable.

[0003] Warning systems have been developed for notifying an operator of a vehicle when the speed of the vehicle is undesirable. Cruise control systems have been developed for regulating the speed of a vehicle. Some of these systems incorporate cameras for imaging passing speed limit signs, which post the current speed limit, as the vehicle travels. A processing unit associated with the warning and/or cruise control systems evaluate(s) images of the speed limit signs for identifying the posted speed limit. The processor then warns the operator and/or regulates the speed of the vehicle to achieve the posted speed limit.

[0004] As noted above, a single section of road in, for example, a school zone may include multiple speed limit signs or a single speed limit sign with different posted speed limits that are in effect at different times. Since exceeding a posted speed limit can have negative consequences such as personal injury, property damage, and fines from speeding tickets, current warning and cruise control systems elect the lower speed limit regardless of whether that lower limit is currently in effect.

[0005] A lower speed limit (e.g., 20 mph) in a school zone may only be in effect a few hours each school day. For non-urban highways, the non-school time posted speed limit may be significantly higher (e.g., 50 mph). Therefore, a camera based warning and/or cruise control system that determine(s) the current posted speed limit by evaluating images of speed limit signs may unnecessarily warn and/or slow a vehicle in the school zone during times when the school speed limit is not in effect.

[0006] The present invention provides a new and improved apparatus and method for warning and cruise control systems.

Summary

[0007] In one aspect of the present invention, it is contemplated that a controller is adapted to receive signals indicative of an image including a representation of a posted speed limit for a current section of a road on which an associated vehicle is traveling. The controller evaluates the image to identify the posted speed limit and dynamically determines if the posted speed limit is above a predetermined threshold speed limit. Only if the posted speed limit is above the predetermined threshold speed limit, the controller sets the identified posted speed limit as a warning threshold. If a speed of the associated vehicle is more than a predetermined range over the warning threshold, the controller transmits a warning signal to a notifier for notifying an operator of the associated vehicle and controls a speed of the vehicle based on the posted speed limit.

Brief Description of the Drawings

[0008] In the accompanying drawings which are incorporated in and constitute a part of the specification, embodiments of the invention are illustrated, which, together with a general description of the invention given above, and the detailed description given below, serve to exemplify the embodiments of this invention.

[0009] **FIGURE 1** illustrates a schematic representation of a vehicle on a road in accordance with one embodiment of an apparatus illustrating principles of the present invention;

[0010] **FIGURE 2** is an exemplary methodology of providing a speed warning and speed control in accordance with one embodiment illustrating principles of the present invention;

[0011] **FIGURE 3** illustrates various signs in accordance with different embodiments of the present invention;

[0012] **FIGURE 4** illustrates a representation of a display in accordance with one embodiment of an apparatus illustrating principles of the present invention; and

[0013] **FIGURE 5** illustrates another representation of a display in accordance with one embodiment of an apparatus illustrating principles of the present invention.

Detailed Description of Illustrated Embodiment

[0014] With reference to **FIGURE 1**, a simplified component diagram of an exemplary vehicle **10** including a system **12** for warning an operator of the vehicle **10** regarding a speed of the vehicle **10** and a system **14** for controlling a speed of the vehicle **10** is illustrated in accordance with one embodiment of the present invention. Although the warning and control systems **12, 14**, respectively, are described as separate and independent

systems, it is contemplated that the warning and control systems **12, 14**, respectively, may also be combined into a single vehicle system.

[0015] The warning system **12** includes a first controller $\mathbf{20_W}$ (e.g., the warning controller), and the control system **14** includes a second controller $\mathbf{20_C}$ (e.g., a speed control controller). If the warning and control systems **12, 14**, respectively, are combined into a single vehicle system, only a single controller **20** is contemplated for both the warning and speed control functions. Therefore, for purposes of discussion, only a single controller **20**, which incorporates the features and functions of the warning controller and the speed control controller, is discussed.

[0016] The vehicle also includes at least one camera **22** that is part of the warning and control systems **12, 14**, respectively. The at least one camera **22** electrically communicates with the controller **20** via, for example, a vehicle communication bus **24**.

[0017] With reference to **FIGURE 2**, an exemplary methodology of the system shown in **FIGURE 1** for warning an operator of the vehicle **10** based on a speed of the vehicle **10** is illustrated. As illustrated, the blocks represent functions, actions and/or events performed therein. It will be appreciated that electronic and software systems involve dynamic and flexible processes such that the illustrated blocks and described sequences can be performed in different sequences. It will also be appreciated by one of ordinary skill in the art that elements embodied as software may be implemented using various programming approaches such as machine language, procedural, object-oriented or artificial intelligence techniques. It will further be appreciated that, if desired and appropriate, some or all of the software can be embodied as part of a device's operating system.

[0018] With reference to **FIGURES 1 and 2**, the camera **22** obtains an image, in a step **110**, of a sign **26** on, for example, a side of a road **30** on which the vehicle **10** is traveling. The camera **22** transmits signals indicative of the image of the sign **26**, in a step **112**, to the controller **20**. **FIGURE 3** illustrates various embodiments of the sign that may be imaged in the step **110** and transmitted to the controller **20** in the step **112**. The signs

26a–26k are signs found in the United States, and the signs **26l–26q** are signs found in the Canada. The sign **26a** is a standard speed limit sign; the sign **26b** is a speed limit sign showing both the (maximum) speed limit and a minimum speed limit; the sign **26c** is an electronic speed limit sign showing the speed limit; the sign **26d** is a school speed limit sign including the word "SCHOOL" and an extension banner **28**; the sign **26e** is a school speed limit sign including the word "SCHOOL" and active school times; the sign **26f** is a standard speed limit sign along with an electronic sign showing the actual speed of an approaching vehicle, the sign **26g** is a sign indicating an approaching speed limit zone, the sign **26h** is a sign indicating a night speed limit; the sign **26i** is a sign indicating different speed limits for passenger cars (e.g., a default speed limit of 70 mph), a different speed limit for trucks (e.g., 60 mph), and a minimum speed limit of 55 mph; the sign **26j** is a sign indicating speed limits for both passenger cars and trucks; and the sign **26k** is a sign indicating both a (maximum) speed limit and a minimum speed limit. The sign **26l** is a standard speed limit sign; the sign **26m** is also a standard speed limit sign; the sign **26n** is sign indicating a night speed limit; the sign **26o** is a school speed limit sign including the word "SCHOOL"; the sign **26p** is a school speed limit sign including the word "SCHOOL" and active school times; and the sign **26q** is a sign indicating both a (maximum) speed limit and a minimum speed limit.

[0019] With reference to **FIGURES 1–3**, the signals indicative of the image of the sign **26** are received in the controller **20** in a step **114**. In one embodiment, the sign **26** includes a representation of at least one posted speed limit for a current section of the road **30** on which the vehicle **10** is traveling. The controller **20** evaluates the signals indicative of the image of the sign **26** (e.g., the sign **26a**) in a step **116**, to identify the at least one posted speed limit (e.g., 25 mph) as respective possible speed limits for the current section of the road **30** on which the vehicle **10** is traveling.

[0020] For example, if two (2) or more speed limits are posted on the sign **26** (see, for example, the sign **26i** in **FIGURE 3**) and if more than one of the posted speed limits are above a predetermined threshold speed limit (e.g., 23 mph), it is assumed a first of the posted speed limits is for a certain type of vehicle and a second of the posted speed limits is for a

second type of vehicle. In the illustrated embodiment, the first type of vehicle is a passenger car, and the second type of vehicle is for trucks (e.g., vehicles having a gross vehicle weight rating greater than 26,000 lbs. (2 tons)). If one of the posted speed limits is not above the predetermined threshold, it is assumed that the lower (e.g., lowest) of the speed limits is the speed limit when a school zone is active and the higher (e.g., highest) of the speed limits is the speed limit when the school zone is not active. Therefore, in a step **120**, the controller **20** determines how many possible speed limits are on the sign **26**. If it is determined in the step **120** that only one (1) possible speed limit is on the sign **26**, control passes to a step **122** for determining if the possible speed limit is above the predetermined threshold speed limit (e.g., 23 mph) and/or if the sign itself indicates a school zone. If it is determined in the step **122** that the possible speed limit is not above the predetermined threshold speed limit, if the sign includes the word "SCHOOL" (see, for example, the sign **26**d in **FIGURE 3**), or if the sign is an elongated sign with an extension banner (see, for example, the sign **26**d in **FIGURE 3**), any of which would indicate a school zone having a speed limit of, for example 20 mph or less, control passes to a step **123** for optionally warning the operator of the vehicle **10** of the possible reduced speed before returning to the step **110** for obtaining a next image of a sign. Otherwise, if it is determined in the step **122** that the possible speed limit is above the predetermined threshold speed limit and that the sign itself does not indicate a school zone, control passes to a step **124** for assigning the possible speed limit on the sign **26** as the posted (e.g., identified) speed limit (e.g., the actual speed limit). Control then passes to a step **126**.

[0021] If it is determined in the step **120** that more than one (1) possible speed limit is on the sign **26**, control passes to a step **130** for determining if none of the possible speed limits on the sign **26** is above the predetermined threshold speed limit (e.g., 23 mph), which would indicate a school zone having a speed limit of, for example 20 mph. If it is determined in the step **130** that none of the possible speed limits is above the predetermined threshold limit, control passes to a step **131** for optionally warning the operator of the vehicle **10** of the possible reduced speed before returning to the step **110**. If, on the other hand, it is determined in the step **130** that any of the possible speed limits on the sign **26** is above the

predetermined threshold speed limit, control passes to a step **132** for identifying the possible speed limits on the sign **26** that are above the predetermined threshold speed limit (e.g., 23 mph). In one example, the sign **26i** includes three (3) speed limits (e.g., a default speed limit of 70 mph, a speed limit of 65 mph for trucks (over 13 tons), and a minimum speed limit of 45 mph). For purposes of discussion, it is assumed the controller **20** recognizes a minimum speed limit (e.g., by recognizing the word "minimum" or the abbreviation "min") and disregards that possible speed limit. In this example, the controller **20** recognizes both 70 mph and 65 mph as possible speed limits.

[0022] In a step **134**, the type of the vehicle **10**, which it is assumed was previously programmed into the controller **20**, is identified. For example, the vehicle **10** may be of a passenger care type or a heavy vehicle type (e.g., a truck at least 26,000 lbs. or 13 tons). In a step **136**, if the vehicle type is a passenger car, the controller **20** assigns the higher (e.g., highest) of the possible speed limits as the posted (e.g., identified) speed limit; otherwise if the vehicle type is a heavy vehicle (e.g., truck), the controller **20** assigns the lower (e.g., lowest) of the possible speed limits as the posted (e.g., identified) speed limit (e.g., the actual speed limit). Control then passes to the step **126**.

[0023] In the step **126**, the posted (e.g., identified) speed limit is set as a warning threshold. Since any possible speed limits not above the predetermined threshold speed limit (e.g., 23 mph) were ignored, only speed limits above the predetermined threshold speed limit (e.g., 23 mph) may be set as the warning threshold. A determination is made, in a step **140**, if an actual speed of the vehicle **10** is more than a predetermined range (e.g., 5 mph) over the warning threshold. If it is determined in the step **140** that the actual speed of the vehicle **10** is not more than the predetermined range over the warning threshold, control returns to the step **110** for obtaining a next image of a sign. Otherwise, if it is determined in the step **140** that the actual speed of the vehicle **10** is more than the predetermined range over the warning threshold, control passes to a step **142**.

[0024] In the step **142**, the controller **20** transmits a signal to a notifier **32** for activating the notifier **32** to ensure the operator of the vehicle **10** is aware that the vehicle **10** is traveling more than the predetermined range over the posted speed limit. With reference to **FIGURE 4**, in one embodiment, the notifier **32** includes a display screen **34** displaying a speed limit sign **36** showing the identified (e.g., actual) speed limit. With reference to **FIGURE 5**, in one embodiment, the notifier **32** also displays a warning message **40** stating, for example, "Over Speed Limit" if the actual speed of the vehicle is over the posted speed limit by more than the predetermined range, for example. In another embodiment, the notifier **32** is a light on a dashboard of the vehicle **10** that is illuminated when the vehicle **10** is traveling more than the predetermined range over the posted speed limit. In yet another embodiment, the notifier **32** is a device making an audible sound when the vehicle **10** is traveling more than the predetermined range over the posted speed limit. Still further, it is contemplated that the notifier **32** is a device making a steering wheel of the vehicle **10** vibrate if the vehicle **10** is traveling more than the predetermined range over the posted speed limit. In a step **144**, the controller **20** transmits at least one signal to speed control components on the vehicle **10** for controlling a speed of the vehicle **10** to be within the predetermined range over the warning threshold. Control then returns to the step **110** for obtaining a next image of a sign.

[0025] The effect of the system and method described above is to not warn the operator of the vehicle **10** or control the speed of the vehicle **10** to limit the speed of the vehicle **10** if the posted speed limit is not more than the predetermined threshold limit. So, for example, if the vehicle **10** is in a school zone, the operator is not warned of the lower speed limit (e.g., $\leq$20 mph). Since the time periods during which school zone speed limits are active, it is assumed the vehicle operator will reduce the speed of the vehicle when necessary.

[0026] In one embodiment, it is contemplated that the controller **20** acts as a means for evaluating the image to identify if the sign indicates a school zone speed limit.

[0027] While the present invention has been illustrated by the description of embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Therefore, the invention, in its broader aspects, is not limited to the specific details, the representative apparatus, and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of the applicant's general inventive concept.

I/We claim:

1. A controller adapted to:

receive signals indicative of an image including a representation of at least one posted speed limit for a current section of a road on which an associated vehicle is traveling;

evaluate the image to identify any of the at least one posted speed limits;

select any of the at least one posted speed limits greater than or equal to a predetermined threshold speed limit as a possible speed limit for the associated vehicle;

determine an identified speed limit for the associated vehicle based on all of the possible speed limits; and

transmit a signal for controlling a speed of the associated vehicle based on the actual speed limit.

2. The controller as set forth in claim 1, wherein the controller is further adapted to:

set the predetermined threshold speed limit as 23 mph.

3. The controller as set forth in claim 1, wherein the controller is further adapted to:

control the speed of the associated vehicle to be within a predetermined range of the identified speed limit.

4. The controller as set forth in claim 1, wherein the controller is further adapted to:

determine the identified speed limit as one of the highest possible speed limit and the lowest possible speed limit.

5. The controller as set forth in claim 1, wherein the controller is further adapted to:

identify the associated vehicle as one of a plurality of vehicle types.

6. The controller as set forth in claim 5, wherein the controller is further adapted to:

determine the identified speed limit based on all of the possible speed limits and the vehicle type of the associated vehicle.

7. The controller as set forth in claim 6, wherein the controller is further adapted to:

identify the vehicle type of the associated vehicle as a heavy vehicle having a gross vehicle weight rating greater than 26,000 lbs.; and

determine the identified speed limit as the lowest of the possible speed limits.

8. The controller as set forth in claim 1, wherein the controller is further adapted to:

transmit a signal for displaying the actual speed limit.

9. A controller adapted to:

receive signals indicative of an image including a representation of a posted speed limit for a current section of a road on which an associated vehicle is traveling;

evaluate the image to identify the posted speed limit;

dynamically determine if the posted speed limit is above a predetermined threshold speed limit;

only if the posted speed limit is above the predetermined threshold speed limit, set the identified posted speed limit as a warning threshold; and

if a speed of the associated vehicle is more than a predetermined range over the warning threshold, transmit a warning signal to a notifier for notifying an operator of the associated vehicle.

10. The controller as set forth in claim 9, wherein the controller is further adapted to:

only if the posted speed limit is above the predetermined threshold speed limit, control a speed of the associated vehicle based on the set posted speed limit.

11. The controller as set forth in claim 9, wherein the controller is further adapted to:

set the predetermined threshold speed limit as 23 mph.

12. The controller as set forth in claim 9, wherein the controller is further adapted to:

set the predetermined range as 5 mph.

13. The controller as set forth in claim 9, wherein the controller is further adapted to:

transmit the warning signal to the notifier for causing the posted speed limit and a warning message to be displayed on the notifier.

14. A controller adapted to:

receive signals indicative of an image of a sign including a representation of a possible speed limit for a current section of a road on which an associated vehicle is traveling;

evaluate the image to identify if the sign indicates a school zone speed limit;

only if the evaluation of the image indicates the sign is not a school zone speed limit, set a warning threshold speed limit to the possible speed limit; and

if a speed of the associated vehicle is more than a predetermined range over the warning threshold speed limit, transmit a warning signal to a notifier for notifying an operator of the associated vehicle.

15. The controller as set forth in claim 14, wherein the controller is further adapted to:

evaluate the image to identify the sign indicates a school zone speed limit if the sign includes the word "SCHOOL".

16. The controller as set forth in claim 14, wherein the controller is further adapted to:

evaluate the image to identify the sign indicates a school zone speed limit if the sign includes an extension banner.

17. The controller as set forth in claim 14, wherein the controller is further adapted to:

only if the evaluation of the image indicates the sign is not a school zone speed limit, control a speed of the associated vehicle based on the warning threshold speed limit.

18. The controller as set forth in claim 14, wherein the controller is further adapted to:

if a speed of the associated vehicle is more than the predetermined range over the warning threshold speed limit, transmit the warning signal to the notifier for causing the warning threshold speed limit and a warning message to be displayed on the notifier.

19. The controller as set forth in claim 18, wherein the controller is further adapted to:

transmit the warning signal to the notifier for causing the an audible message to be conveyed from the notifier.

20. A method for setting a warning threshold speed limit, the method comprising:

receiving signals indicative of an image of a sign including a representation of a possible speed limit for a current section of a road on which an associated vehicle is traveling;

evaluating the image to identify if the sign indicates a school zone speed limit;

only if the evaluation of the image indicates the sign is not a school zone speed limit, setting a warning threshold speed limit to the possible speed limit; and

if a speed of the associated vehicle is more than a predetermined range over the warning threshold speed limit, transmitting a warning signal to a notifier for notifying an operator of the associated vehicle.

21. The method for setting a warning threshold speed limit as set forth in claim 20, further including:

only if the posted speed limit is above the predetermined threshold speed limit, controlling a speed of the associated vehicle based on the set posted speed limit.

22. The method for setting a warning threshold speed limit as set forth in claim 20, further including:

transmitting the warning signal to the notifier for causing the posted speed limit and a warning message to be displayed on the notifier.

23. The method for setting a warning threshold speed limit as set forth in claim 20, further including:

evaluating the image to identify the sign indicates a school zone speed limit if the sign includes the word "SCHOOL".

24. The method for setting a warning threshold speed limit as set forth in claim 20, further including:

evaluating the image to identify the sign indicates a school zone speed limit if the sign includes an extension banner.

25. The method for setting a warning threshold speed limit as set forth in claim 20, further including:

if a speed of the associated vehicle is more than the predetermined range over the warning threshold speed limit, transmitting the warning signal to the notifier for causing the warning threshold speed limit and a warning message to be displayed on the notifier.

26. A method for identifying and controlling a speed, the method comprising:

receiving signals indicative of an image including a representation of at least one posted speed limit for a current section of a road on which an associated vehicle is traveling;

evaluating the image to identify any of the at least one posted speed limits;

selecting any of the at least one posted speed limits greater than or equal to a predetermined threshold speed limit as a possible speed limit for the associated vehicle;

determining an identified speed limit for the associated vehicle based on all of the possible speed limits; and

transmitting a signal for controlling a speed of the associated vehicle based on the actual speed limit.

27. The method for identifying and controlling a speed as set forth in claim 26, further including:

setting the predetermined threshold speed limit as 23 mph.

28. The method for identifying and controlling a speed as set forth in claim 26, further including:

controlling the speed of the associated vehicle to be within a predetermined range of the identified speed limit.

29. The method for identifying and controlling a speed as set forth in claim 26, further including:

determining the identified speed limit as one of the highest possible speed limit and the lowest possible speed limit.

30. The method for identifying and controlling a speed as set forth in claim 26, further including:

identifying the associated vehicle as one of a plurality of vehicle types.

31. The method for identifying and controlling a speed as set forth in claim 30, further including:

determining the identified speed limit based on all of the possible speed limits and the vehicle type of the associated vehicle.

32. The method for identifying and controlling a speed as set forth in claim 26, further including:

transmitting a signal for displaying the actual speed limit.

33. The method for identifying and controlling a speed as set forth in claim 32, further including:

transmitting a signal for displaying a warning message if the speed of the associated vehicle is greater than the actual speed limit by a predetermined range.

34. A controller adapted to:

receive signals indicative of an image of a sign including a representation of a possible speed limit for a current section of a road on which an associated vehicle is traveling;

means for evaluating the image to identify if the sign indicates a school zone speed limit;

only if the evaluation of the image indicates the sign is not a school zone speed limit, set a warning threshold speed limit to the possible speed limit; and

if a speed of the associated vehicle is more than a predetermined range over the warning threshold speed limit, transmit a warning signal to a notifier for notifying an operator of the associated vehicle.

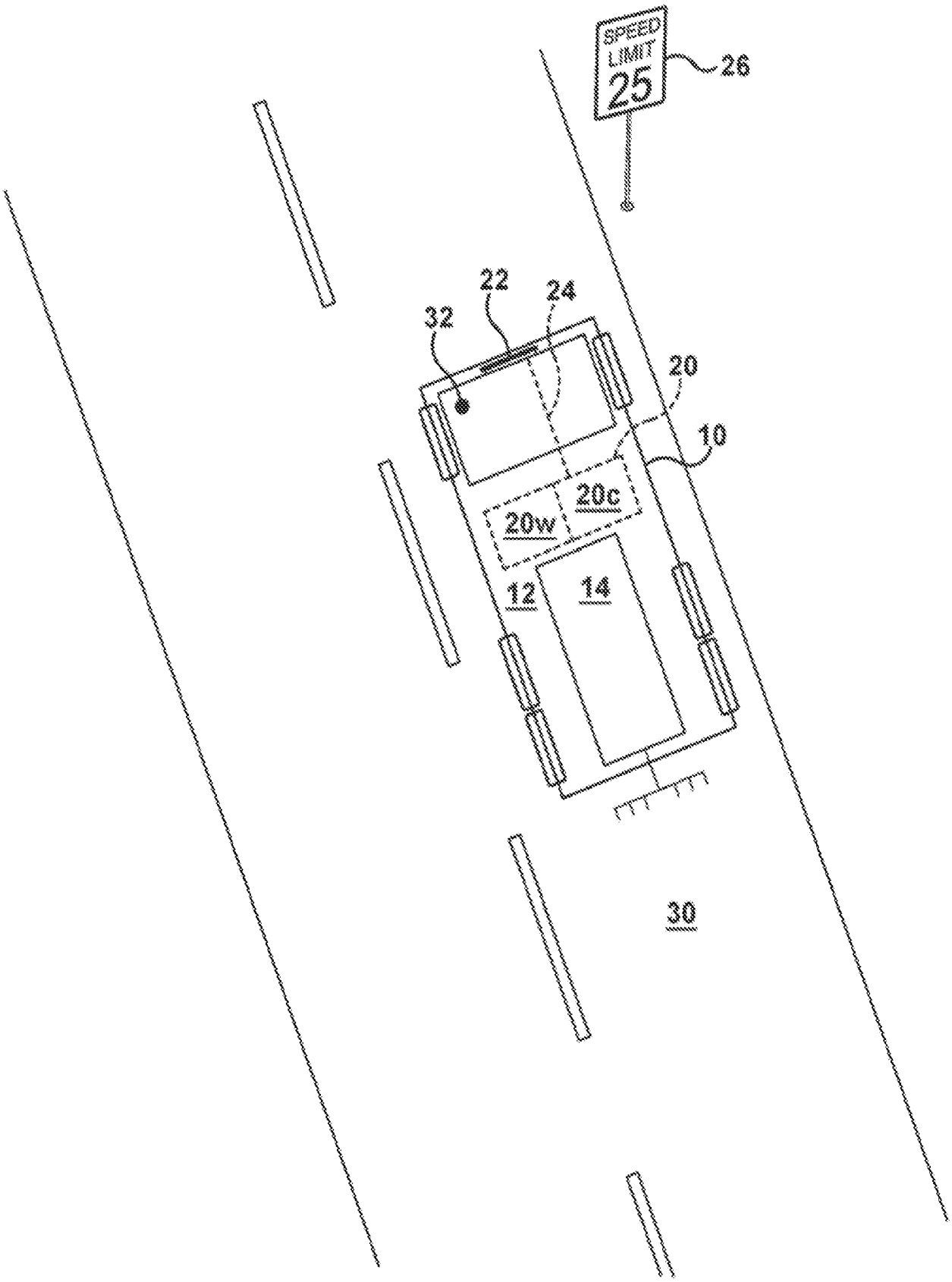

Fig. 1

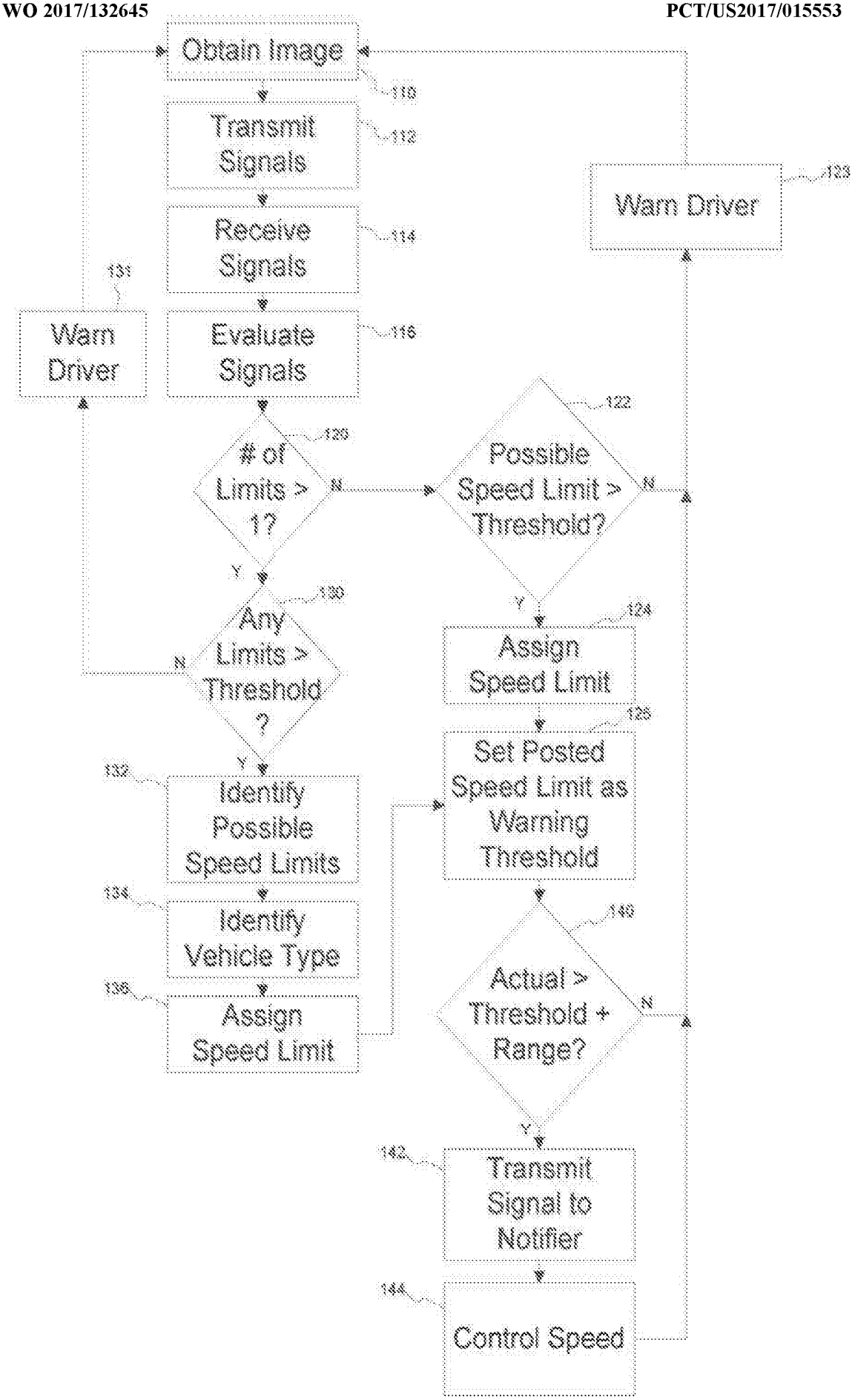
Obtain Image
110
Transmit Signals
112
Receive Signals
114
Evaluate Signals
116
Warn Driver
131
Warn Driver
133
# of Limits > 1?
120
N
Y
Possible Speed Limit > Threshold?
122
N
Y
Any Limits > Threshold ?
130
N
Y
Assign Speed Limit
124
Set Posted Speed Limit as Warning Threshold
126
Identify Possible Speed Limits
132
Identify Vehicle Type
134
Assign Speed Limit
136
Actual > Threshold + Range?
140
N
Y
Transmit Signal to Notifier
142
Control Speed
144

FIG. 2

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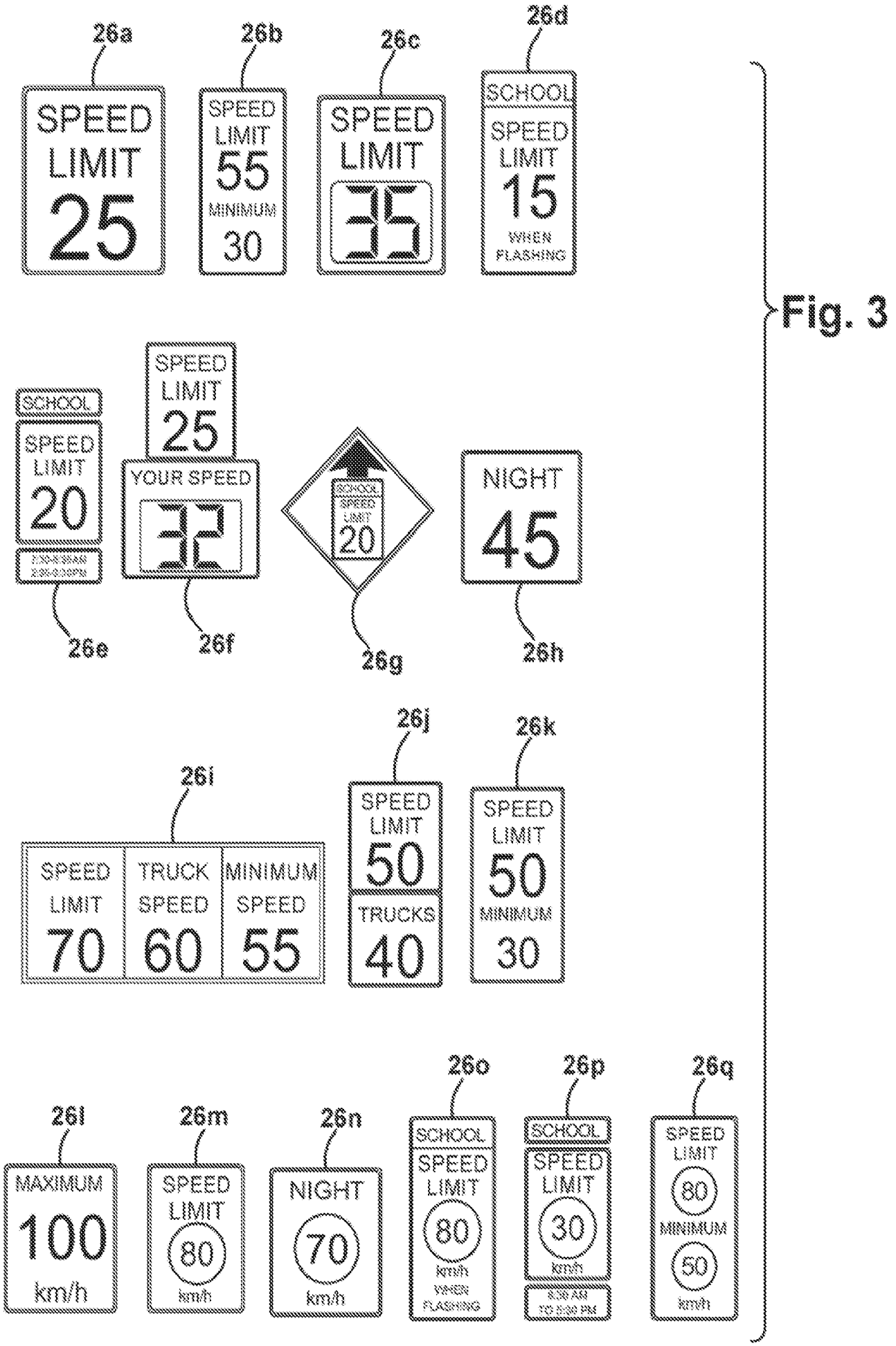

Fig. 3

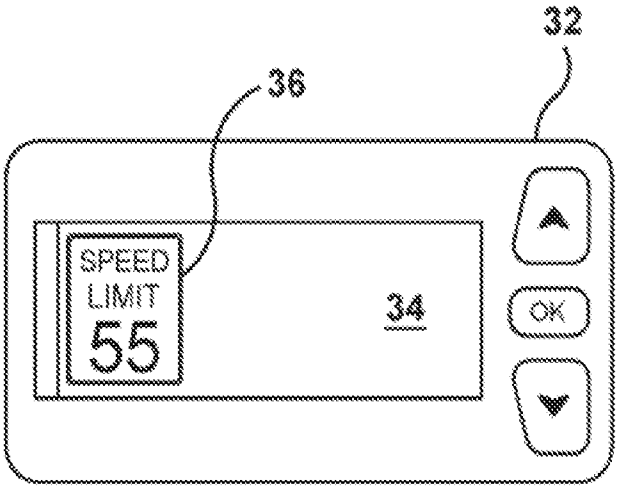
32
36
SPEED
LIMIT
55
34
OK

Fig. 4

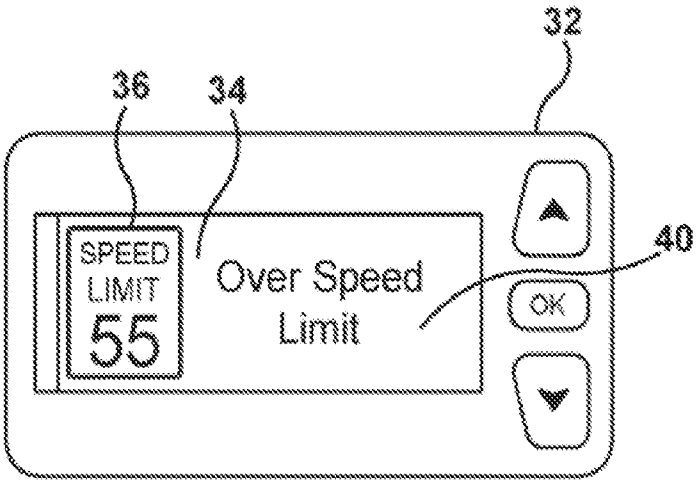
32
36
34
SPEED
LIMIT
55
Over Speed
Limit
40
OK

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/015553

A. CLASSIFICATION OF SUBJECT MATTER
INV. G08G1/0962 G08G1/0967
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G08G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014/300741 A1 (WEY TORSTEN [DE] ET AL) 9 October 2014 (2014-10-09) paragraphs [0012], [0020] - paragraph [0046]; figure 2	1-34
X	DE 10 2008 057675 A1 (DAIMLER AG [DE]) 2 July 2009 (2009-07-02) paragraph [0017] - paragraph [0025]; figures	1-34
A	US 2014/119605 A1 (ZOBEL MATTHIAS [DE]) 1 May 2014 (2014-05-01) paragraph [0015] - paragraph [0020]; figures	15,16, 23,24

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 May 2017	24/05/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Malagoli, M

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2017/015553

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